

GEOCHEMISTRY OF VOLCANIC ROCKS FROM THE WAWA GREENSTONE BELT, ONTARIO, Klaus J. Schulz, U.S. Geological Survey, Reston, VA 22092, Paul J. Sylvester, Dept. of Earth and Planetary Sciences, Washington University, St. Louis, MO 63130, and K. Attoh, Dept. of Geology, Hope College, Holland, MI 49423

The Wawa greenstone belt is located in the District of Algoma and extends east-northeast from Lake Superior to the western part of the Sudbury District in Ontario, Canada. Recent mapping by Attoh (1,2) has shown that an unconformity at the base of the Doré Formation and equivalent sedimentary rocks marks a significant stratigraphic break which can be traced throughout the volcanic belt. This break has been used to subdivide the volcanic-sedimentary succession into pre- and post-Doré sequences (2). The pre-Doré sequence includes at least two cycles of mafic-to-felsic volcanism, each capped by an iron-formation unit. The post-Doré sequence includes an older mafic-to-felsic unit, which directly overlies sedimentary rocks correlated with the Doré Formation, and a younger felsic breccia unit interpreted to have formed as debris flows from a felsic volcanic center (2).

In the present study, samples from both the pre- and post-Doré volcanic sequences were analyzed for major and trace elements, including rare earths (REE). This preliminary study is part of an ongoing program to assess the petrogenesis of the volcanic rocks of the Wawa greenstone belt.

#### Pre-Doré Volcanic Rocks

Two volcanic suites have been recognized in the pre-Doré volcanic sequence. The first is represented by tholeiitic basalts which apparently make up only a small part of the sequence. These are similar in both major and trace elements to typical Archean tholeiitic basalts such as those of the Ely Greenstone in the Vermilion District of Minnesota (3,4). The other and more abundant suite is calc-alkaline and represented by basaltic andesites, dacites and rhyolites. Andesites (i.e.  $\text{SiO}_2=54-62$  wt.%) appear to be largely absent.

The basaltic andesites have high  $\text{Al}_2\text{O}_3$  contents, enriched light REE ( $[\text{La}/\text{Sm}]_N=1.9-3.3$ ), lower contents of Sc and Co, and higher contents of Hf, Zr, Ta, and Th compared with the tholeiitic basalts.

Of the three dacites analyzed, one has REE abundances similar to the basaltic andesites except for a small negative Eu anomaly, and has Sc, Co, Cr, Ta, Th, Hf, and Zr values intermediate between the basaltic andesites and rhyolites. The other two dacites, sampled from the area of Michipicoten Harbour, are distinctive in having highly depleted heavy REE abundances and steep REE patterns ( $[\text{La}/\text{Yb}]_N=22-23$ ).

The rhyolites are generally similar in composition (except one sample from west of Andre Lake and two samples from the Michipicoten Harbour area), having enriched light REE ( $[\text{La}/\text{Sm}]_N=3.8-4.2$ ), negative Eu anomalies, and low compatible element contents. These rhyolites tend to lie along the compositional trends defined by the basaltic andesite and dacite samples implying that they may be the product of fractional crystallization from the same parent magma. However, the apparent lack of andesites, if substantiated, may require a more complex model for the petrogenesis of these rhyolites. The two rhyolites from the Michipicoten Harbour area, when compared with the major rhyolite group, have higher REE abundances with larger negative Eu anomalies, markedly higher heavy REE contents, and are also enriched in other incompatible elements. The rhyolite from west of Andre Lake has lower REE, Hf, Zr, Ta, Th, Sc and Co abundances than the major rhyolite group and shows no Eu anomaly.

## Post-Doré Volcanic Rocks

Tholeiitic and calc-alkaline suites are both present in the post-Doré volcanic sequence. The tholeiitic suite forms part of the older post-Doré volcanic unit and is represented solely by basalts which are compositionally similar to those of the lower sequence. The rest of this older unit is composed of calc-alkaline rhyolites which can be divided into low SiO<sub>2</sub> (71-74 wt.%) and high SiO<sub>2</sub> (78-79 wt.%) groups. These rhyolites have steeper REE patterns than the lower volcanic unit rhyolites. The low SiO<sub>2</sub> rhyolites have no or small Eu anomalies, whereas the high SiO<sub>2</sub> rhyolites have prominent negative Eu anomalies, lower Sr (<90 ppm), and variable light REE abundances (La=20-48 ppm). The high SiO<sub>2</sub> rhyolites probably represent fractionated melts of the low SiO<sub>2</sub> rhyolite group.

Two samples analyzed from the younger felsic breccia unit are dacitic in composition, have high Sr contents (305 and 477 ppm), steep REE patterns ([La/Yb]<sub>N</sub>=10.7 and 21.7) with [La]<sub>N</sub>=74 and 204, and small negative Eu anomalies.

## Discussion

The present data show that although the tholeiitic basalts of the pre- and post-Doré volcanic sequences are compositionally similar, the calc-alkaline suites are not. Although andesites appear to be largely absent from the pre-Doré calc-alkaline suite, the general compositional continuity of the basaltic andesites, dacites and rhyolites suggests some co-genetic relationship.

The rhyolites of the older post-Doré volcanic sequence are compositionally distinct, particularly in terms of their REE patterns, from the pre-Doré rhyolites (i.e., post-Doré rhyolites have lower heavy REE abundances, steeper REE slopes and the low SiO<sub>2</sub> rhyolites lack Eu anomalies). The apparent lack of more mafic calc-alkaline rocks in this post-Doré sequence makes a fractional crystallization origin for these rhyolites unlikely and suggests they may be a product of partial melting.

Campbell and others (5) have shown that Archean felsic volcanic rocks associated with Cu-Zn massive sulfide mineralization have flat REE patterns with well-developed Eu anomalies whereas rhyolites from barren volcanic sequences have steeper REE patterns with weak or absent Eu anomalies. The rhyolites of the Wawa greenstone belt (both pre- and post-Doré) appear to have the general REE characteristics of the latter group, which is consistent with the lack of known massive sulfide mineralization in the Wawa belt.

## References

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